(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 260 989**
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 87308291.1

(22) Date of filing: 18.09.87

(51) Int. Cl.[4]: **F 24 H 1/20**
F 24 D 3/08, F 24 D 19/08,
F 24 H 9/12

(30) Priority: 18.09.86 GB 8622520

(43) Date of publication of application:
23.03.88 Bulletin 88/12

(84) Designated Contracting States: DE ES FR GB IT

(71) Applicant: Carruthers, Thomas Robison
53 Ormonde Avenue
Muirend Glasgow, G44 3QY Scotland (GB)

(72) Inventor: Carruthers, Thomas Robison
53 Ormonde Avenue
Muirend Glasgow, G44 3QY Scotland (GB)

(74) Representative: Szczuka, Jan Tymoteusz et al
Cruikshank & Fairweather 19 Royal Exchange Square
Glasgow G1 3AE Scotland (GB)

(54) **Domestic hot water cylinder and system.**

(57) According to this invention there is provided a cylinder (1) suitable for domestic hot water storage, which in an upright position has an upper interior divided into adjacent upper and lower chambers (C,B) defined by a base (2), partitioning wall (3) and the cylinder roof (4), and a lower interior constituting a main water storage chamber (A). A primary duct (6) extends upwardly of the partitioning wall (3) allowing communication between the upper and lower chambers (C,B). At least one secondary duct (5) extends downwardly of the partitioning wall (3) allowing communication between the upper chamber (C) and the main water storage chamber (A). The lower chamber (B) has an automatic air vent (11), and means (10) suitable for connection to a water heating circuit (F,G). The invention also extends to a hot water storage and central heating system incorporating such a cylinder.

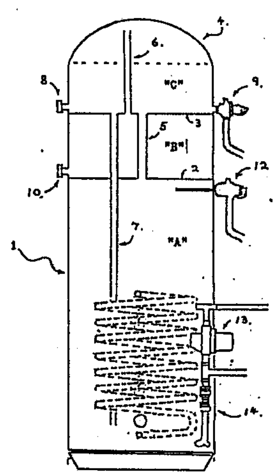

FIG. I

EP 0 260 989 A2

Description

DOMESTIC HOT WATER CYLINDER AND SYSTEM

This invention concerns domestic hot water storage cylinders and heating systems incorporating such cylinders.

The principle of heating water for domestic purposes has in the majority of residences become merged with heating the rooms by water-filled radiators by a single heat source. The medium of water serves to heat both (1) the domestic hot water, and (2) the central heating radiators. It is necessary to keep the water in these services physically separate by e.g. means of a heat exchange device. The water in the domestic services is to be kept clean and uncontaminated by the normally dirty radiator water. Similarly the central heating water should be kept inert and unaffected by dissolved air normally present in the domestic water services.

The principle of physical separation of these water services is well known and largely attained by having two independent water services served by a single heat source and connected for the transfer of heat from one to another by a heat exchanger. Contemporary practice is founded on heating the domestic hot water supply in a storage container. This is referred to as an 'indirect' cylinder, the bulk of stored water being heated, in use, by a heat exchanger coil (although other forms may be found) which is connected to the primary central heating system, both services being heated by one central boiler.

This contemporary practice has the disadvantage that two separate water systems leads to duplication of technical components and a consequent higher cost. The traditional method in the United Kingdom is based on both domestic hot water and the central heating water services requiring a separate high level cold water supply cistern and each with its own mains input supply, overflow discharge pipe, feed connecting pipe and open vent safety pipe.

GB-A-2 001 740 provided a system for avoiding this duplication so that one set of services could be utilised for both (1) the domestic hot water, and (2) the central heating system.

The patented system relies upon dissolved air naturally found in water and its release upon heating. The air is collected in a vessel to keep the secondary domestic water separate from the primary central heating water.

There exists a demand towards 'unvented' domestic heating systems in which the intermediate storage cistern within the domestic residence is eliminated and the public reservoir is used instead as a direct feed supply to the hot water system.

In 'unvented' systems the domestic hot water services are no longer supplied from a high level cold water storage cistern, which has an open vent to atmosphere. As unvented systems do not have an open vent it is necessary to introduce safety measures or devices, if not sold with the cylinder then certainly prior to actual operation, to make the system safe and to accommodate normal operation and malfunction.

Domestic hot water storage and central heating systems may now require (a) an inlet water pressure regulating valve, (b) a pressure relief valve, and (c) a temperature relief valve (preferably including an anti-vacuum function). These principal safety controls can be suppledmented by an expansion vessel to accommodate thermal expansion and/or contraction of the bulk of stored hot water as it heats and cools.

Such mechanical safety controls form part of the unvented domestic hot water system, the primary central heating system being physically and mechanically separate.

The 'sealed' central heating system has been in use in this country for some time with certain drawbacks. This type of system, because it has no open vent to atmosphere, requires an expansion vessel to accommodate expansion and contraction of the primary heating system. Pressure exerted within the primary system seeks out the weakest points of minor leakage, e.g. the packing gland of radiator valves. The sealed system hitherto used does not have a permanent facility for replenishing lost water. The primary system only has to loose a 'cup' of water per week to be a failure.

If the unvented domestic water heating system were to be used together with the sealed central heating system this would involve duplication of all the mechanical safety control devices previously described.

The present invention seeks to provide a cylinder and system in which the unvented domestic hot water system can be combined with the sealed central heating system. The mechanical safety control mechanisms may serve both services with savings in cost and service maintenance.

According to this invention there is provided a cylinder suitable for domestic hot water storage, which in an upright position has an upper interior divided into adjacent upper and lower chambers defined by a base, partitioning wall and the cylinder roof, a lower interior constituting a main water storage chamber, a primary duct extending upwardly of the partitioning wall allowing communication between the upper and lower chambers, at least one secondary duct extending downwardly of the partitioning wall allowing communication between the upper chamber and the main water storage chamber, said lower chamber having a vent to atmosphere, in the form of an automatic air vent, and means suitable for connection to a water heating circuit. The invention also extends to a hot water storage and central heating system incorporating such a cylinder.

This invention eliminates the need for a separate expansion vessel by providing integral chambers for accommodating expansion and contraction of both the domestic store of hot water, and also the primary central heating system. The invention may provide 'make-up' water to the primary heating system which may be required from e.g. minor leakages. The invention may allow the pressure exerted on both the domestic stored water and the primary heating circuits to be equal. Both services may be influenced equally by the pressure entering from the street mains through a pressure reducing valve. This valve may be pre-set at any required in-put pressure, e.g. 0.45 BAR (7 lbs per square inch).

This operating pressure will enable a normal BSS 1566 GRADE 3 copper hot water cylinder to be utilised as the main storage cylinder, with cost savings. The pressure relief valve when fitted to the cylinder may be set at any required break pressure, e.g. only 1 BAR (14 lbs per square inch). In practice this means that the normal operating pressure on both the domestic hot water service and also the central heating system would be euqivalent to an ordinary two storey house, traditionally with a highlevel storage cistern in the attic. The invention is designed to exploit the release of 'dissolved air' naturally found in water and to use this as a functional component. The invention may render the primary system inert, removing the dissolved air from the central heating system, and maintaining such status. The release of dissolved air from the secondary hot water storage is considerable being some 2% of water volume. In practice this means there is about 1/2 gallon of dissolved air in every 25 gallons of stored hot water. This means that there is in normal use a constant rejuvenatory discharge of dissolved air from the domestic stored hot water into the functional air collecting chambers(s).

In embodiments of the present invention the pysical volumeof the vessel capable of maintaing an air seal is substantially enhanced compared to the system described in GB-A-2 001 740 at minimal cost insofar as the upper and lower chambers can be simply provided as a short extension of the relatively large diameter cylinder normally used for conventional hot water storage systems.

Suitable cylinders for use in the present invention include, for example, a standard BSS1566 Indirect Cylinder, or BSS699 Direct Cylinder. It will be appreciated from the following detailed description of a preferred embodiment, that the upper part of a standard hot water cylinder can be modified so as to provide the air collecting chamber(s).

In order that the invention may be illustrated and readily carried into effect, an embodiment thereof applied to an indirect cylinder will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a sectional view of a domestic cylinder showing selected internal and external features;

Figure 2 is a partly cut-away corresponding view showing further external fittings; and

Figure 3 illustrates the cylinder and chambers containing water during initial priming or use.

Referring to Figures 1 and 2 of the drawings which show part of an 'unvented' domestic hot water storage and central heating system, the storage cylinder 1 is fed by direct mains through stop valve 20 and strainer 19 to pressure regulating valve 13.

The pressure reducing valve can be pre-set to the required out-put pressure. This is followed by a cold water supply outlet 17 which has the advantage of equalizing the input pressure to both the hot and cold household supply - with a resulting advantage in the function of these services, particularly the operation of a hot and cold shower. Just before entering the normal cold feed supply point 15 in the hot storage cylinder 1, there is positioned a non-return valve 14. This is to prevent back-pressure into the main supply, which would result from expansion of the stored hot water during heating.

The bulk of the hot water is contained within the storage cylinder compartment "A". Constructed integrally within the upper interior of the cylinder are the two adjacent chambers - the lower serving as the primary expansion chamber "B", the upper expansion chamber "C" serving as secondary domestic supply service. Lower chamber "B" is defined by the cylinder space contained between base 2 extending the full internal width of the cylinder and partitioning wall 3 also extending the full width of the cylinder 1. The upper chamber "C" is defined by the cylinder space between partitioning wall 3 and the internal roof 4, comprising a conventional domed top. The chambers are in communication but in a manner to separate the primary central heating water from the secondary 'draw-off' hot water supply, the internal pressure on both sides of these 'separating' chambers being equal, and not requiring to sustain any pressure differential between them.

The whole of the hot water storage vessel is contained within the cylinder 1. This will usually be constructed to the pressure requirements of BS1566 or BSS699 - in accordance with the grade calling for respective operating pressure. The main water storage chamber or compartment "A" is in communication with the upper chamber"C" by means of a secondary duct 5, which transcommunicates from compartment "A" to chamber "C", without communicating with the intervening lower chamber "B".

A primary duct 6 extends upwardly from the partitioning wall 3 to open communication with the top of chamber "C" and spaced from the roof 4. A further secondary duct 7 extends downwardly from the partitioning wall 3 through chamber "B" but not in communication therewith towards the cylinder base within main storage compartment "A".

The upper chamber "C" provides the domestic hot water storage/supply, being intercommunicated through duct which is an open tube, to the main (domestic) storage compartment "A". This upper chamber provides a hot water draw-off 8 at a point adjacent the partitioning wall to the household fittings. There is also on the same horizontal plane towards the bottom of chamber "C" a pressure relief valve 9 incorporating an external discharge pipe and preferably also an anti-vacuum device.

Also on this horizontal plane can be provided an automatic air vent 9a of the type commercially available under the Trade Mark "Purg-O-Mat", which will release any surplus of dissolved air accumulated in chamber "C" which is not otherwise dishcarged through the hot water draw-off 8.

Chamber "B" provides primary central heating supply. Adjacent base 2 is the connection 10 suitable for primary heating circuit, see Figure 2. Also on the same horizontal plane adjacent base 2 is an automatic air vent 11, for example, the type sold under the Trade Mark "Purg-O-Mat" formed and arranged for automatic closing by the rising water after completion of venting. Towards the top of compartment "A" there is a temperature and pressure relief valve 12, incorporating an anti-vacuum function and external discharge pipe.

A coiled copper tubular heat exchanger is shown at 16 (Figure 1) for connection to the primary heating circuit, incorporating pump 18 (Figure 2), boiler flow line "F", boiler return line "G", heating flow line "D" and heating return line "E".

The filling and operation of the system is described with reference to Figures 1 and 3. Water enters the cylinder compartment "A" by way of the cold feed inlet 15 at the bottom, being connected from pressurized street mains, and passes through the stop valve 20, strainer 19, pressure regulating valve 13 pre-set to a pressure acceptable to the primary and secondary circuits, and the non-return valve 14. The pressure reduced cold water enters the main storage compartment "A" and proceeds to fill the entire cylinder and the major part of upper chamber "C". The auto-air vent 11 in chamber "B" is wide open as is also the air vent 9a in chamber "C", so that as cold water enters the storage cylinder air is automatically expelled. Compartment "A" continues to fill and the water rises through secondary duct 5 into chamber "C". The air vent 11 continues to vent air and the water level in chamber "C" rises until it reaches the top of the primary duct 6, the automatic air vent 9a having been closed by the water level rising above it. This water then spills over this tube 6 and pours into the lower (primary water) chamber "B". The water in the primary storage vessel "B" continues to fill, and water from this pour through the primary connection 10 to fill the entire primary central heating system, which includes the boiler and radiator system (not shown). The primary heating system continues to fill while the automatic air vent 11 continues to expel air. Eventually the water fills the entire primary system and the water level then rises in the primary chamber "B", so that water then enters the auto-vent 11 raising the automatic air vent float control and so preventing further air expulsion. The instant the auto-vent closes the water which was pouring over the primary duct 6 from "C" stops at the lip of this duct, having trapped atmospheric air in chamber "B" from the water level set by the auto-vent. Air is trapped in (i) chamber "B", from this water level to the partitioning wall 3, in (ii) the primary duct 6, and (iii) above the end of this duct to the cylinder roof 4. The level of the domestic stored water in chamber "C", at this stage, is at the said top of the primary duct 6.

The entire system is then ready for normal operation, and the boiler can be switched on enabling the primary circuit to heat up. Before doing this, however, the chamber "C" can be primed with atmospheric air by a manual process, e.g. the cold water control stop valve from the street mains is temporarily turned off. The pressure release valve 9 in "C" is then manually opened, being fitted with a manual operating level for this purpose. The water in "C" then drains out through the discharge pipe attached to the pressure relief valve, while simultaneously the anti-vacuum valve opens and draws atmospheric air into "C". Once chamber "C" is fully primed with atmospheric air the street mains control stop valve can then be turned on. The effect of this manual action is to artificially fill the upper section of "C" with a cushion of air. This atmospheric air which has been trapped in the upper portion of the chamber is compressed to the pressure set by the incoming reduced-pressure mains water supply. It should be noted that chamber "C" is designed to accumulate air expelled from the water which would otherwise be continually present in the stored domestic hot water in compartment "A". As this stored hot water is continually heated and replaced there is a continuous release of dissolved air which rises by its own bouyancy from compartment "A", and passes through the secondary duct 5 into "C". The accumulation of this air in "C", together with the previously 'trapped' atmospheric air in the lower chamber "B", is important to functional operation.

Air is compressible, and this acts as an air cushion, to accommodate the expansion and contraction in both the primary and secondary water systems. The physical size of chambers "B" and "C" can be varied by an accommodation in the height of the cylinder wall. The diameters correspond to that of the cylinder itself. The actual dimensions can be determined by an assessment of the amount of expansion volume which will result from heating both the primary central heating system, and also the stored domestic hot water in compartment "A". It has been assessed that both the primary and secondary water volumes have to allow for an increase in volume due to heating of some 4% of volume. Since air is compressible, while water is not, it is therefore a function of the air cushion in both chambers "B" and "C" to accommodate this expansion in volume. An assessment requires to be made to take account of all modes of operation. For the purposes of example, the pressure relief valve 9 in "C" is set to open when the pressure reaches 10 pounds per square inch. Similarly the temperature and pressure relief valve 12 is set to open at a slightly higher pressure of 12 pounds per square inch. It will be observed that both these relief valves are set to operate at a pressure slightly below the maximum pressure required by the grade of cylinder for normal operation (i.e. - BSS1566 - Grade 3 = 14 pounds per square inch).

The normal mode of operation would assume that when the boiler sarts to heat, the primary central heating system, including the radiators, will heat and expand first. Shortly afterwards heat transferred through the primary heating coil in the indirect cylinder will begin to heat and expand the secondary stored water. Immediately the domestic hot water draw-off tap at the household fittings was used this would instantly relieve and equalize all expansion pressure within the storage vessel. For the purpose of assesment, however, it should be assumed that during the initial mode of operation this draw-off tap will not be used. The primary central heating water, which is the content of the boiler, the primary pipe-work, and the radiators will expand, upon heating, some 4% of volume. The size of the primary chamber "B" can accommodate such volumetric expansion. As the primary water heats the water level previously set by the auto-vent 11 rises in chamber "B" and pushes the air previously trapped therein upwards, through the primary duct 6 into chamber "C". This air is compressed in proportion to the primary system volumetric expansion and taking account of its initial volumetric capacity. it should be noted the air content already accumulated in chamber "C" had previously been manually increased After a delay in time the primary heating coil in "A" will heat the stored domestic hot water, and depending upon the initial stored volume of the cylinder, will also expand some 4% of volume. It would be possible to design the communicating air cushions to accommodate the maximum expansion of both the primary and secondary water simultaneously. However, since normal domestic applications run the draw-off to the household taps, this immediately relieves and equalizes the internal pressure due to expansion of both systems. Minor relief of pressure through the pressure relief valve 9 under maximum operational mode may be permitted. There are two pressure relief valves in the embodiment described since manual relief valves can stick in the closed position when they are only infrequently actuated.

In a normal operational mode, both the primary and secondary water is free to expand and contract as it heats and cools. The physical size of chamber "B" can be sufficient to permit expansion and contraction of even the largest primary central heating system, without fear of inter-mixing primary water with secondary storage supply. Similarly the stored domestic hot water is free to expand and contract as it heats and cools, and there is a continual release of dissolved air from the water in cylinder compartment "A" as this water is heated. It is estimated that some 2% of the volume of cold water from the street mains is dissolved air, and this is released by the act of heating the water. By its normal bouyancy this dissolved air accumulates in chamber "C". Eventually this chamber provides an optimum air cushion and any surplus of air is discharged mildly through the draw-off outlet to the taps upon opening of these, or released through the automatic air vent 9a. Should both, or either, of the primary or secondary water systems be in a fully heated state and at maximum expansion, then upon the boiler being switched off allowing the systems to cool and contract, the anti-vacuum function preferably in both pressure relief valves comes into operation. Upon the volume in the main compartment contracting, the anti-vacuum valves open and admit atmospheric air to the cylinder, thus enhancing the air-cushion. The normal mode of operation of the system is to continually maintain and enhance this air cushion. The water to air interface of the primary central heating water system within "B" is free to rise and fall therein, without agitation of this interface, as the primary water heats and cools, and surprisingly it has been found that oxygenated air cannot enter the primary water system through this interface.

A supplementary function is attributed to the further secondary duct 7 as shown in Figure 1 or 3. This duct is to induce natural convection flow through the other secondary duct to ensure the hottest water is always available in the upper chamber "C", where it can then be drawn-off to the household taps.

It is equally important to consider any possible malfunction of the system. In the event of failure of the incoming pressure regulating valve 13, allowing mains pressure to bear upon the storage cylinder, there are two pressure relief valves to accommodate this, the upper valve 9 set to open at e.g. 10 psi, and the lower valve 12 set to open at 12 psi. Under malfunction consideration should be given to an event such as the boiler 'boiling'. Although normally the present system would be fitted with a 'protected' boiler, i.e. a boiler fitted with a 'high-limit' thermostat, if excess pressure caused an accidental 'boiling' of the boiler, this excess pressure should be relieved through either of the two pressure relief valves 9 and 12, both of which are independently discharged outside to atmosphere.

Once the cause of malfunction was corrected, the air seal within the chambes would automatically re-establish, to restore operation to normal mode. The tempeature and pressure relief valve 12 in compartment "A" can take account of the need to relieve pressures which could result from temperature increases beyond pre-set level. This could occur by failure of an electrical immersion heater fitted with an automatic thermostat. This relief valve 12 will open on both temperature and pressure malfunction.

Figure 2 shows a substantial part of a domestic hot water storage and central heating system according to the invention. It can be seen that one set of pressure regulating the relief valves may serve both the domestic hot water services and the central heating system simultaneously with resulting saving in costs.

The Figures 1 to 3 illustrate how a standard BSS1566 indirect cylinder, manufactured to normal dimensions, and founded on a diameter of 450mm will have a height which is the standard height plus 350mm, which is accounted for by the assessed physical dimension and height of both chambers "B" and "C". This design criteria may apply to all BSS Copper Cylinders of 450mm diameter. It will be possible to construct cylinders and systems to these principles for any other selected diameter, while taking account of the physical volume required in the chambers "B" and "C".

It will of course be apreciated that any references herein to cylinder are not restricted in scope to any specific geometrical shape of vessel or container and merely reflect the terminology most commonly used for domestic hot water storage containers. If desired, the cylinder of the invention can also be used for a domestic hot water supply solely (i.e. without central heating) simply by sealing off the water heater circuit connection means 10.

Claims

1. A cylinder (1) suitable for domestic hot water storage, which in an upright position has an upper interior divided into adjacent upper and lower chambers (C,B) defined by a base (2), partitioning wall (3) and the cylinder roof (4), a lower interior constituting a main water storage chamber (A), a primary duct (6) extending upwardly of the partitioning wall (3) allowing communication between the upper and lower chambers (C,B), at least one secondary duct (5) extending downwardly of the partitioning wall (3) allowing communication between the upper chamber (C) and the main water storage chamber (A), said lower chamber (B) having a vent to atmosphere, in the form of an automatic air vent (11), and means (10) suitable for connection to a water heating circuit (F,G).

2. A cylinder according to claim 1 wherein the upper chamber (C) is also provided with an automatic air vent (9a).

3. A cylinder according to claim 1 or claim 2 wherein is provided a second secondary duct (7) extending downwardly of said base (2) into proximity with a lower end of the main water storage chamber (A).

4. A cylinder according to any of claims 1 to 3 wherein at least one of the main water storage chamber (A) and the upper chamber (C) is provided with a pressure relief valve (12,9).

5. A cylinder according to any one of claims 1 to 4 wherein the upper end of said at least one secondary duct (5) is disposed at or in proximity to the upper side of said partitioning wall (3) and has a lower end at or in proximity to the underside of said base (2) of the upper interior of the cylinder.

6. A cylinder according to any one of claims 1 to 5 wherein the main water storage chamber (A) is provided with a mains water inlet supply connection means (15).

7. A cylinder according to claim 6 wherein said connection means (15) is provided with a pressure reducing valve (13) and a non-return valve (14).

8. A hot water storage and central heating system incorporating a cylinder (1) according to any one of claims 1 to 7.

0260989

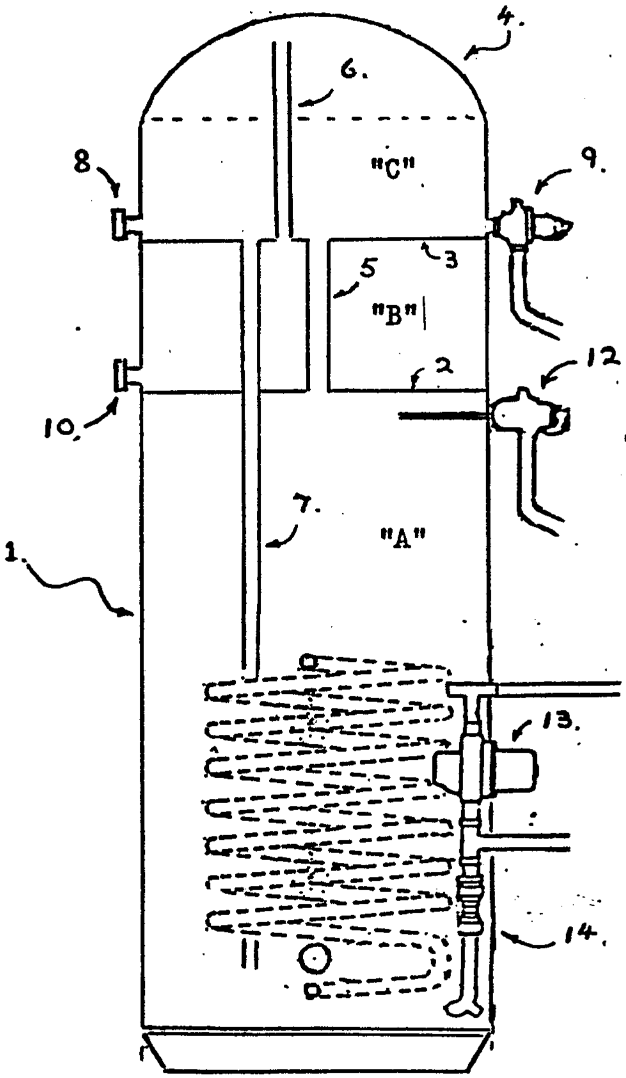

FIG. 1

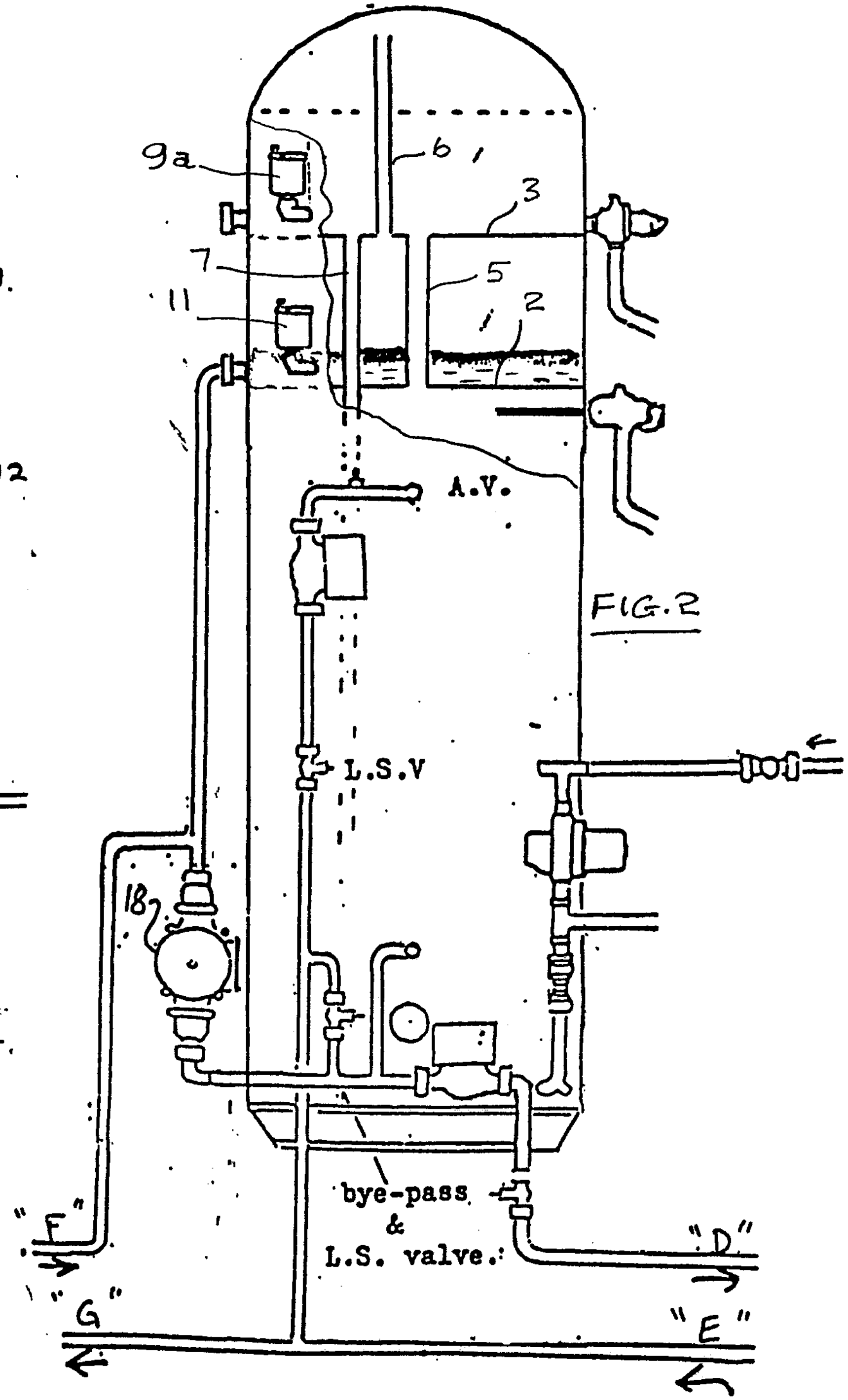

FIG. 2

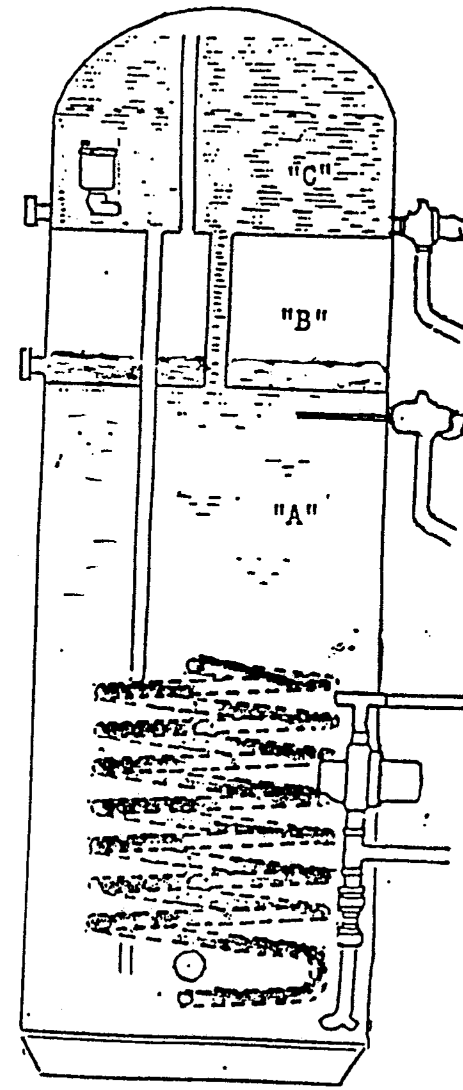

FIG. 3